In April 2016 the Pediatric Anesthesia and Neurodevelopment Assessment (PANDA) team at Columbia University Medical Center held its fifth symposium on potential neurotoxicity of anaesthetic agents in paediatric patients. October's issue of Journal of Neurosurgical Anaesthesiology has two articles summarising presentations and panel discussions that may take your interest.

1. What Next After GAS and PANDA?

Ing C, Rauh V, Warner D, Sun L

Journal of Neurosurgical Anesthesiology 2016; **28** (4): 381-383

This article covers discussions and presentations convened by panel experts in the fields of surgery, anaesthesia, neuropsychology, and epidemiology to determine the level of confidence in the current clinical evidence. The causal relationship between anaesthesia exposure and neurodevelopmental deficit is difficult to establish using observational data. Available data must be used to direct current and future clinical trials to answer the question of causality. (E.g. General Anaesthesia compared to Spinal Anaesthesia (GAS) study and T-Rex involving dexmedetomidine (+/- remifentanil/regional blocks) vs. volatile-based techniques). Two notable challenges exist in planning these trials; firstly what procedures would plausibly put children at risk where the characteristics of the exposure are unknown? Secondly what are the relevant outcomes? Evidence suggests that if there is injury, there may be subtle changes in language and cognition that may not be reflected in developmental measures obtained in the first few years of life, or more broad measures such as academic achievement tests. The article discusses the recognition that the continuum of data seen in studies of other toxic environmental exposures, such as lead poisoning, has not been established in the anaesthetic neurotoxicity literature, specifically regarding the timing of exposure, dose effects, contributing perioperative conditions, or vulnerable populations.

2. Optimal Timing of Surgical Procedures in Pediatric Patients

Ko RR, Pinyavat T, Stylianos S, et al

Journal of Neurosurgical Anesthesiology 2016; **28** (4): 395-399

In 2015 SmartTots, a partnership between the US Food and Drug Administration and International Anesthesia Research Society, issued an updated consensus statement urging health care providers to answer questions from parents related to the risks of anaesthetic neurotoxicity and to discuss timing of procedures with all members of the health care team. A consistent message to parents from paediatricians, anaesthetists, and surgeons is currently lacking. Following multiple specialty-specific examples in general, urology,

ophthalmology and neurosurgery, panel member Houck observed that guidelines are urgently needed to balance the potential risk of anaesthetic neurotoxicity with a surgical "critical window" specific to each surgical procedure. For example, procedures critical to the development of language and vision may outweigh possible anaesthetic-related neurotoxicity. At the time of publication the AAP Surgical Advisory Panel Optimal Timing Task Force was in the intent phase for the policy statement for surgical specialty-specific recommendations to better describe the optimal timing of non-urgent procedures in infants and children. Interdisciplinary dialogue is also emphasised, enabling a consistent message to spread amongst specialties and surgeons to turn to their anaesthetic colleagues for advice on these issues.

Further reading:

Ramsay J, Roizen M. SmartTots: a public-private partnership between the United States Food and Drug Administration (FDA) and the International Anesthesia Research Society (IARS). *Paediatric Anaesthesia* 2012; **22** (10): 969-972

SmartTots.org. Consensus statement on the use of anaesthetic and sedative drugs in infants and toddlers. Available: http://smarttots.org/about/consensus-statement/

3. Development and Validation of a Risk Stratification Score for Children With Congenital Heart Disease Undergoing Noncardiac Surgery

Faraoni D, Vo D, Nasr V, DiNardo J

Anesthesia & Analgesia 2016; **123** (4): 824-830

The objective of this study was to identify the predictors of postoperative in-hospital mortality (primary outcome) in children with major and severe congenital heart disease (CHD) undergoing non-cardiac surgery and to develop a risk stratification score. A retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program Pediatric database (183,423 children between 2012-14), included 4375 children with major CHD (e.g. tetralogy of Fallot with wide open pulmonary insufficiency) and severe CHD (e.g. children with documented pulmonary hypertension) in the derivation cohort (2012-13, mortality: 4.7% [204]) and 2869 in the validation cohort (2014, morality: 4.0% [115]). Eight statistically significant preoperative predictors were distilled in the final multivariable logistic regression model: emergency procedure, severe CHD, single-ventricle physiology, previous surgery within 30 days, inotropic support, preoperative cardiopulmonary resuscitation, acute or chronic kidney injury and mechanical ventilation. The risk stratification score ranging from 0 to 10 showed very good calibration/discrimination in the validation cohort (area under the curve: 0.831 [95% CI:

0.787-0.875]). Scores ≤ 3 are associated with low risk of mortality (OR: 1.54, 95% CI: 0.78-3.04), 4 to 6: medium risk (OR: 4.19, 95% CI: 2.56-6.87), and ≥ 7: high risk (OR: 22.15, 95% CI: 15.06-32.59). This study demonstrated that, in addition to preoperative markers of critical illness, the type of lesion (e.g. single-ventricle physiology) and the functional severity of the heart disease are strong predictors of in-hospital mortality in children undergoing non-cardiac surgery.

4. End of life care for infants, children and young people with life-limiting conditions: planning and management

NICE guideline NG61, December 2016

Key relevant recommendations:

Resuscitation plans or limitation of treatment agreements may need to be changed when a child is undergoing general anaesthesia.

Consider discussion about beliefs and thoughts regarding organ or tissue donation. Some children may not be suitable to donate for transplantation to but may consider donation for research.

Pain should be treated with regular pre-emptive medication and breakthrough analgesia as required. Identify and manage different types of pain appropriately e.g. neuropathic, acute, gastrointestinal, bone, musculoskeletal, etc. Consider non-pharmacological interventions such as massage and music therapy.

Consider pharmacological and non-pharmacological therapies to manage other distressing symptoms such as agitation, seizures and respiratory distress.

Nutrition and hydration must be assessed and the difficult distinction of fluid for comfort versus prolonged artificial hydration must be considered. If this is initiated it must reviewed regularly.

5. Caudal analgesia and cardiothoracic surgery: a look at postoperative pain scores in a pediatric population.

Nguyen KN, Byrd HS, Tan JM

Pediatric Anesthesia 2016; **26** (11): 1060-1063

Previous studies have demonstrated the use of caudal blocks to reduce the stress response and reduce time to extubation in congenital cardiac surgery. This study aimed to assess whether post-operative pain scores and opioid use were reduced when caudal anaesthesia

is used in cardiac surgery with cardiopulmonary bypass. Inclusions: 0-18 years, open cardiac surgery for ASD, VSD, or TOF repair. Exclusions: prolonged hospital course, prolonged intubation, incomplete anaesthetic or intensive care records. Methods: 3.5 years of charts were reviewed retrospectively from a single centre in North America. The cases were divided into non-caudal and caudal groups, that received a single shot caudal prior to the start of surgery of bupivacaine 0.25% (1ml/kg up to 20ml) with clonidine (2mcg/kg) and preservative free morphine (40mcg/kg up to 2.5mg). Patients then underwent sevoflurane general anaesthesia and cardiopulmonary bypass. Opioid use for 24 hours post-op was calculated as a morphine-weight equivalent dose. Data for pain scores (CRIES score for neonates, FLACC score for 2 months to 7 years), up to 24 hours were analysed. Results: 199 patients divided into a caudal group (n=86) and non-caudal group (n=113). There was a significant difference in the ages and weights between the two groups, with the caudal group having younger and lighter patients. Intra-operatively: significantly less opioid use in the caudal group ($P<0.0002$). No significant differences between the two groups in the 24-hour postoperative period for opioid use or pain scores. No complications were reported relating to the caudal block. Limitations: retrospective, no blinding, potential use of opioid for sedation rather than analgesia in the intensive care environment.

6. SCAI/CCAS/SPA Expert Consensus Statement for Anesthesia and Sedation Practice: Recommendations for Patients Undergoing Diagnostic and Therapeutic Procedures in the Pediatric and Congenital Cardiac Catheterization Laboratory

Odegard KC, Vincent R, Baijal R et al

Catheterization and Cardiovascular Interventions 2016; **88**: 912–922

The Society for Cardiovascular Angiography and Interventions (SCAI), the Society for Pediatric Anesthesia (SPA) and the Congenital Cardiac Anesthesia Society (CCAS) formed an expert panel to make recommendations for optimal management of patients undergoing paediatric congenital cardiac catheterization laboratory (PCCCL) procedures, including types of anaesthesia, level of monitoring, and the personnel necessary. The panel reviewed published data describing the rate of adverse events, common complications, and the risk factors for these, including the underlying cardiac pathologies and the types of catheterization procedures. There is a discussion about type of anaesthesia, with emphasis on volume status and ventilation strategies. The next section features recommendations for the planning and provision of healthcare professionals, with emphasis on multidisciplinary planning and communication, and the use of peri-procedural checklists. The final section touches on the future of individualised resource planning through use of risk scoring systems.

7. The effect of ultrasound-guided transversus abdominis plane (TAP) block on postoperative analgesia and neuroendocrine stress response in pediatric patients undergoing elective open inguinal hernia repair

Abu Elyazed MM, Mostafa SF, Abdullah MA, Eid GM

Pediatric Anesthesia 2016; **26** (12): 1165–1171

This study evaluated the effect of transversus abdominis plane (TAP) block on the modification of the surgical stress response and its analgesia effect, in paediatric patients 3–10 years, ASA I-II, undergoing elective unilateral open inguinal hernia repair. 60 patients were randomized into two groups: general anaesthesia only versus ipsilateral ultrasound-guided transverses abdominis plane (TAP) block (0.4ml/kg bupivacaine 0.25%), following induction of general anaesthesia. All operations were performed in the morning, as the first case, to equalize circadian changes in the stress hormone levels, and all children were premedicated orally with midazolam. The two groups were comparable with respect to age, gender and body weight. Serum cortisol and blood glucose were used as markers of the neuroendocrine stress response. Patients in the TAP group required less intraoperative fentanyl, less postoperative paracetamol, quality of analgesia was significantly better, and children and their parents were more satisfied. Serum cortisol and blood glucose levels were significantly lower in the TAP group, 30 min after surgical incision and and 30 min postoperatively. There was no significant difference in cortisol levels at 24 h postoperative. There are some limitations: other indicators of stress response such as serum catecholamines were not examined; pain assessment was done during rest only; and the study was not double blinded.

8. The influence of age on positions of the conus medullaris, Tuffier's line, dural sac, and sacrococcygeal membrane in infants, children, adolescents, and young adults

Jung J-Y, Kim EH, Song IK, Lee J-H, Kim H-S, Kim J-T

Pediatric Anesthesia 2016; **26** (12): 1172–1178

Magnetic resonance imaging, and plain lumbar X-ray films of the same patients were reviewed retrospectively. 350 patients aged 1 month to 20 years were included. Results: The distance between the conus medullaris and Tuffier's line (line joining 2 highest points of iliac crests, landmark to guide lumbar spinals) was narrower in younger children, especially those younger than 2 years. The level of each was also lower in younger patients. The distance between the conus medullaris and the Tuffier's line ranged from 1.5-4.75 vertebral body height. Under 2 years the maximum range was 2.5 vertebral body height. Infants aged 1–6 months had the lowest mean distance among the seven age subgroups. The mean vertebral level of the conus medullaris in infants aged 1–6 months was L2, and it was L1 in those aged

15–20 years. There was no difference between male and female. Tuffier's line ranged from L1 to S1, with an average level of L5. Lumbar puncture for spinal block should be performed at L4/L5 or L5/S1 in neonates or infants to avoid spinal cord injury.

The distance from the dural sac to the SCM increased with age. The position of the dural sac did not change according to age (S1-S2). Advancement of the needle along the canal should be minimized, especially in younger children, to avoid accidental dural puncture during caudal block in small children. This study had some limitations: it did not include neonates and did not consider changes in position such as lumbar flexion during a spinal block.

9. Guidelines on the Prevention of Post-operative Vomiting in Children

Martin S, Baines D, Holtby H, Carr A

The Association of Paediatric Anaesthetists of Great Britain & Ireland, Autumn 2016

http://www.apagbi.org.uk/sites/default/files/images/2016%20APA%20POV%20Guideline-2.pdf

Strength of Recommendation: (*for other C strength recommendations, see guideline)*

- Unconditional (UC): Strong evidence, no important drawbacks
- Conditional (C): Weaker evidence, serious potential drawbacks

Patient Factors associated with a high risk of POV:

- Risk of POV increases > 3 years old and continues to rise throughout early childhood into adolescence ***UC***
- A previous history of POV is an independent risk factor of subsequent POV in children ***UC***

Surgical procedures associated with a high risk of POV:

- Children undergoing strabismus surgery are at high risk of POV ***UC***
- Tonsillectomy +/- Adenoidectomy ***UC***

Anaesthetic factors affecting POV in children:

- Use of volatile anaesthetic agents is associated with increased risk of emesis particularly in children who have other risk factors for POV ***UC***

Summary of recommendations for prevention of POV in children:

- Children at increased risk of POV should be given IV ondansetron 0.15 mg/kg prophylactically ***UC***
- Children at high risk of POV should be given prophylactically IV ondansetron 0.15 mg/kg and IV dexamethasone 0.15 mg/kg ***UC***

Summary of recommendations for treatment of established POV in children:

- IV ondansetron 0.15 mg/kg should be given to children who have not already been given ondansetron for prophylaxis of POV ***UC***
- For children who have already been given ondansetron a second antiemetic from another class should be given, such as: IV dexamethasone 0.15 mg/kg injected slowly or IV droperidol 0.025 mg/kg ***C***

10. Gastric ultrasound as a preoperative bedside test for residual gastric contents volume in children

Schmitz A, Schmidt AR, Buehler PK et al.

Pediatric Anesthesia 2016; **26** (12): 1157–1164

Gastric ultrasound (US) is attractive for the preoperative evaluation of patients who are at risk for aspiration, but is limited to an indirect assessment of gastric contents volume (GCV) by measuring the cross-sectional area of the best visible part, the gastric antrum, as a surrogate parameter. This study aimed to evaluate the potential of US as a pre-anaesthetic diagnostic test, using gastric MRI volumetry as the reference for comparison. The study included 18 healthy children (ASA I or II) with a mean age of 9.8 (6.8–12.2) years. 72 US examinations were carried out in different positions, after various periods of fasting, or after drinks and meals. Gastric US using the right lateral decubitus position was superior to the SUBE (supine position with upper body degree elevated to 45°) position for measurement of cross sectional area as a surrogate for gastric residual volumes. Although direct calculation of GCV remains imprecise, US as a non-invasive bedside technique may support pre-anaesthetic assessment of the risk of perioperative pulmonary aspiration in clinical practice. A major limitation of the presented study is the restricted age range and lack of blinding for the US examiner. They likened the cross-sectional area technique to deducing the weight of a pear from a cross-section of its thinnest part! Also the limit of acceptable GCV is not known and thus a cut off volume cannot be defined.

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